

Amendments to the Specification:

Please replace the title with the following amended title:

~~"Method of inserting a wave winding into a stator of a polyphase rotating electrical machine, and its associated stator."~~

METHOD OF INSERTING A WAVE WINDING INTO A STATOR OF A POLYPHASE ROTATING ELECTRICAL MACHINE AND ITS ASSOCIATED STATOR

Please insert the following heading after the title:

BACKGROUND OF THE INVENTION

Please replace the heading after the title with the following amended heading:

~~Field of the invention~~1. Field of the Invention.

Please delete paragraph [0002].

Please replace the heading before paragraph [0003] with the following amended heading:

~~Prior art~~2. Description of the Related Art.

Please replace paragraph [0005] with the following amended paragraph:

[0005] Stators formed by this method have on both sides of the laminations very tightly packed winding overhangs, offering high resistance to the circulation of air. Moreover, the winding overhangs are non-symmetrical, one of the winding overhangs having an axial height greater than that of the other winding overhang, which is also ~~unfavourable~~ unfavorable for the circulation of air for cooling these winding overhangs.

Please replace the heading after paragraph [0008] with the following amended heading:

~~Object of the invention~~SUMMARY OF THE INVENTION

Please add the following new paragraph after paragraph [0009]:

[0009.1] More precisely, the invention concerns according to a first aspect a method of inserting a wave winding into a stator of a rotating electrical machine, such as a motor vehicle alternator or alternator starter, the stator comprising laminations with a hole through the centre and having an axis of symmetry and slots passing through axially made in a radially inner face of the laminations, these slots providing a plurality of receiving positions arranged in tiers radially, the winding comprising a plurality of phase windings each consisting of an electrically conductive continuous wire, the method comprising the following steps:

- 1) shaping each winding, the wire thereof being formed into a succession of crenellations connected by linking segments, each crenellation comprising two lateral branches facing one another each intended to be inserted at a receiving position of a slot, and a top branch connecting the two lateral branches;
- 2) placing the windings on an insertion tool;
- 3) inserting the turns into the slots of the stator.

Please replace paragraph [0010] with the following amended paragraph:

[0010] To this end, the method of the invention, in other respects conforming to the generic definition given by the preamble above, is essentially ~~characterised~~ characterized in that step 2) of placing the windings is implemented on a cylindrical insertion tool, each winding constituting several turns around the insertion tool, these turns being superimposed in a given order, and in that the windings are wound around the insertion tool at the same time, the turns that follow one another in said given winding order belonging alternately to the different windings.

Please replace paragraph [0019] with the following amended paragraph:

[0019] Similarly, the linking segments connect two respective lateral branches of two ~~neighbouring~~ neighboring crenellations along the wire and have a curved shape, these segments forming a winding overhang on a second axial side of the stator opposite to the first. By virtue of the invention, non-symmetrical or symmetrical winding overhangs with air passages between the inside and outside of the winding overhangs can be obtained.

Please replace paragraph [0032] with the following amended paragraph:

[0032] According to a second aspect, the invention concerns a stator of a polyphase rotating electrical machine, such as a motor vehicle alternator or alternator starter, this stator comprising laminations with a hole through the centre having an axis of symmetry, slots passing through axially made in a radially inner face of the laminations each providing a plurality of receiving positions arranged in tiers radially, and a winding comprising a plurality of phase windings each consisting of an electrically conductive continuous wire;

the wire of each winding being formed into a succession of crenellations connected by linking segments, each crenellation comprising two lateral branches opposite one another each coming to be inserted at a receiving position of a slot, and a top branch connecting the two lateral branches;

each winding constituting several turns around the stator;

the turns of the windings being inserted into the slots in a given order, the lateral branches of these turns progressively occupying radially more inner positions;

~~characterised~~ characterized in that the turns that follow one another in said given order belong alternately to the different windings.

Please replace paragraph [0036] with the following amended paragraph:

[0036] Moreover, the linking segments connect two respective lateral branches of two ~~neighbouring~~ neighboring crenellations along the wire and have a curved shape, these segments forming a winding overhang on a second axial side of the stator opposite to the first.

Please insert the following new paragraph after paragraph [0047]:

[0047.1] These and other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

Please replace the heading after paragraph [0047.1] with the following amended heading:

~~Brief description of the drawings~~BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Please replace paragraph [0049] with the following amended paragraph:

[0049] ~~—Figures~~ Figs. 1A and 1B are axial views of part of a stator, respectively obtained in accordance with the method of the prior art and in accordance with the method of the invention;

Please replace paragraph [0050] with the following amended paragraph:

[0050] ~~—Figures~~ Figs. 2A and 2B are perspective views of the stators of ~~Figures~~ Figs. 1A and 1B;

Please replace paragraph [0051] with the following amended paragraph:

[0051] ~~—Figure~~ Fig. 3A is an expanded schematic representation of a phase winding of the stator of ~~Figures~~ Figs. 1B and 2B, after shaping at step 1);

Please replace paragraph [0052] with the following amended paragraph:

[0052] ~~—Figure~~ Fig. 4 is an expanded schematic representation of three phase windings of the stator of ~~Figures~~ Figs. 1B and 2B, showing the areas where these three windings cross in the stator after insertion, the circles indicating the areas of local shaping;

Please replace paragraph [0053] with the following amended paragraph:

[0053] —Figure Fig. 5 is a side view of the insertion tool after placing of the windings on this tool at step 2);

Please replace paragraph [0054] with the following amended paragraph:

[0054] —Figure Fig. 6 is a perspective view along arrow VI of Figure Fig. 5;

Please replace paragraph [0055] with the following amended paragraph:

[0055] —Figures Figs. 7A and 7B are schematic representations illustrating step 3 of inserting the turns into the slots of the stator by axial movement of the insertion tool;

Please replace paragraph [0056] with the following amended paragraph:

[0056] —Figure Fig. 8 is a side view of the laminations and the insertion tool at step 3);

Please replace paragraph [0057] with the following amended paragraph:

[0057] —Figure Fig. 9 is a perspective view along arrow IX of Figure Fig. 8;

Please replace paragraph [0058] with the following amended paragraph:

[0058] —Figure Fig. 10 is a schematic side view of a stator obtained in accordance with the invention; and

Please replace paragraph [0059] with the following amended paragraph:

[0059] —Figures Figs. 11A, 11B and 11C are schematic representations of the cross-sections respectively of a slot of a stator of the invention with a width corresponding to one wire diameter, to two wire diameters and a slot of a stator of the prior art.

Please replace the heading after paragraph [0059] with the following amended heading:

~~Description of example implementations of the invention~~ **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

Please replace paragraph [0061] with the following amended paragraph:

[0061] In the implementation assembly the stator 1 comprises a body in the form of cylindrical laminations 10 having an axial axis of symmetry 20 (~~Figure~~ Fig. 10), and axial slots 30 made in a radially inner face 11 of the laminations 10. The slots 30 are separated from one another by axial ribs 35 referred to as teeth (~~Figures~~ Figs. 11A, 11B).

Please replace paragraph [0062] with the following amended paragraph:

[0062] These slots 30 pass axially right through the laminations 10 with a hole through the ~~centre~~ center since they extend over the entire axial length of the laminations 10 and are open radially on an inner side and at the two opposite axial ends. These slots 30 each provide a plurality of receiving positions arranged in tiers radially.

Please replace paragraph [0063] with the following amended paragraph:

[0063] The winding 50 comprises a plurality of phase windings 70 each consisting of an electrically conductive continuous wire 60 (~~Figures~~ Figs. 3 and 4). The wire is for example made from copper covered with an insulator such as varnish. Each phase winding 70 comprises several turns 73, one turn corresponding to one stator body revolution.

Please replace paragraph [0064] with the following amended paragraph:

[0064] In a known manner, a slot insulator, visible in ~~Figure~~ Fig. 2B, is interposed between the wires and the edge of the slots.

Please replace paragraph [0065] with the following amended paragraph:

[0065] The wires 60 and the phase windings 70 form winding overhangs 40, 40' outside the laminations 10, either side thereof, as can be seen for example in Figures-Figs. 2B and 10. These winding overhangs can be well spaced out and compact by virtue of the insertion method according to the invention.

Please replace paragraph [0066] with the following amended paragraph:

[0066] The method comprises the following steps:

- 1) shaping each winding 70;
- 2) placing the windings 70 on an insertion tool 80 (Fig. 5);
- 3) inserting the turns 73 into the slots 30 of the stator.

Please replace paragraph [0067] with the following amended paragraph:

[0067] In the first step, the wire 60 of the winding is formed into a succession of crenellations 71 connected by linking segments 72, as illustrated in Figure-Fig. 3. Each crenellation 71 comprises two lateral branches 711 facing one another each intended to be inserted at a receiving position of a slot 30, and a top branch 712 connecting the two lateral branches 711.

Please replace paragraph [0068] with the following amended paragraph:

[0068] The slots each provide a plurality of positions for receiving lateral branches arranged in tiers radially on several levels (Figures-Figs. 11A to 11C).

Please replace paragraph [0071] with the following amended paragraph:

[0071] In the second step, the placing of the windings is, according to one characteristic, implemented on a cylindrical tool, as illustrated in Figure-Fig. 5. Each winding 70 constitutes several turns 73 around the insertion tool 80.

Please replace paragraph [0075] with the following amended paragraph:

[0075] In the third phase, the insertion of the turns 73 into the slots 30 of the stator 1 is implemented in the reverse order to the winding order, by means of the tool 80, the lateral branches 711 of these turns 73 progressively occupying radially more inner positions as the turns 73 are inserted, as illustrated in Figures-Figs. 7A and 7B.

Please replace paragraph [0077] with the following amended paragraph:

[0077] It can be seen in Figure-Fig. 5 that the insertion tool 80 comprises a plurality of fingers 81 parallel to the axial axis of symmetry of the tool, disposed in a circle, having free ends turned on an upper axial side of the tool, these fingers being separated by gaps 82.

Please replace paragraph [0087] with the following amended paragraph:

[0087] Thus, in the winding overhangs 40, 40', the top branches 712 and the linking segments 72 of the turns of the same series are not aligned radially but on the contrary shifted angularly with respect to one another, as seen in Figure-Fig. 2B.

Please replace paragraph [0089] with the following amended paragraph:

[0089] According to another characteristic of the invention that can be seen in Figure-Fig. 5, the crenellations 71 extend in respective planes parallel to the axis of symmetry of the insertion tool 80, or slightly inclined with respect to this axis, once the turns 73 are wound on the insertion tool 80.

Please replace paragraph [0092] with the following amended paragraph:

[0092] As shown in Figures-Figs. 7A and 7B, the tool 80 comprises, besides the fingers 81, a mushroom 83 movable axially at the centre of the cylinder constituted by the fingers 81. The mushroom 83 has an external diameter practically equal to the internal diameter of the cylinder constituted by the fingers 81.

Please replace paragraph [0094] with the following amended paragraph:

[0094] The tool 80 moves, here axially along the axis 20 of ~~Figures~~ Figs. 7A, 7B, upwards in order to insert the turns 73, the fingers 81 and the mushroom 83 moving, here axially, parallel during a first phase of inserting the lateral branches 711 into the slots 30, then during a second phase the fingers 81 remaining stationary whilst the mushroom 83 continues to move.

Please replace paragraph [0097] with the following amended paragraph:

[0097] The fingers 81 come to a halt, and the mushroom 83 continues to move, so that it pushes the top branches 712 axially upwards, as shown in ~~Figure~~ Fig. 9.

Please replace paragraph [00102] with the following amended paragraph:

[0102] Furthermore, the ~~organisation~~ organization of the turns 73 around the insertion tool 80 allows a highly efficient transmission of the pushing force of the mushroom 83 on the turns 73 furthest away therefrom, that is to say the turns 73 disposed highest on the insertion tool 80.

Please replace paragraph [0106] with the following amended paragraph:

[0106] As shown in ~~Figure~~ Fig. 3, the winding 70 at the end of step 1) extends in a longitudinal general direction, the lateral branches 711 all extending substantially transversely and all being disposed parallel to one another in a longitudinal alignment.

Please replace paragraph [0109] with the following amended paragraph:

[0109] As will be noted in ~~Figure~~ Fig. 3, all the lateral branches 711 have the same length transversely, but the axial height of the curved top branches 712 and the linking segments 72 varies along the winding 70. Axial height of the curved top branches 712 and the linking segments 72 means the height considered in the transverse direction.

Please replace paragraph [0112] with the following amended paragraph:

[0112] In the example of Figure Fig. 1, all the top branches 712 and the linking segments 72 of the same turn 73 have the same height.

Please replace paragraph [0117] with the following amended paragraph:

[0117] Winding overhangs are thus obtained where all the elements have the same axial height, as shown in Figure Fig. 2B.

Please replace paragraph [0119] with the following amended paragraph:

[0119] This other variation, which is added to the first, means that the top branches 712 or the linking segments 72 of the same winding overhang will have a height that increases or decreases from the outside towards the inside. The stator of the prior art depicted in Figure Fig. 1A has such an arrangement in tiers of the top branches 712 and the linking segments 72 of its winding overhangs. This configuration of winding overhangs facilitates cooling.

Please replace paragraph [0123] with the following amended paragraph:

[0123] These areas 61 are marked by circles in Figure Fig. 4.

Please replace paragraph [0131] with the following amended paragraph:

[0131] In the case where the slots 30 have a circumferential width corresponding to the diameter of the wire 60, the lateral branch 711 occupying the most radially inner position, that is to say the closest to the internal periphery of the laminations 10, is deformed by broadening in a circumferential direction, as shown in Figure Fig. 11A. Said lateral branch 711 rests on the two opposite radial faces of the slot and is thus locked in position in the slot 30. The lateral branches 711 occupying the other positions are thus held inside the slot 30.

Please replace paragraph [0133] with the following amended paragraph:

[0133] In the case where the slots 30 have a circumferential width equal to at least two diameters of the wire 60 (Figure-Fig. 11B), these slots 30 have, on a radially inner side, an opening 31 partially closed on two opposite sides by two axial steps 32, also referred to as tooth feet, projecting from the teeth 35. The lateral branches 711 occupying each slot 30 are held inside it by a flat wedge 33 resting on the steps 32 on an inner side of the slot 30, as shown in Figure-Fig. 11B.

Please replace paragraph [0137] with the following amended paragraph:

[0137] As shown in Figures-Figs. 11A and 11B, the dimensions chosen for the slots 30 mean that the lateral branches 711 of the wire 60 normally come to be arranged in several well-ordered radial alignments at step 3) of insertion into the slots 30.

Please replace paragraph [0144] with the following amended paragraph:

[0144] On account of the alternation of the turns of the different windings in the insertion order, the winding overhangs are particularly well spaced out. Cooling of the winding overhangs is thus greatly facilitated. The flow of cooling air through the winding overhangs can then exceed 10 litres-liters per second.

Please replace paragraph [0148] with the following amended paragraph:

[0148] It also results from the good preparation of the areas where the wires cross, which makes it possible to arrange the winding overhang well and therefore optimise optimize the position of the lateral branches 711 in the slots well.

Please replace paragraph [0150] with the following amended paragraph:

[0150] It should be noted that the substantially vertical positioning of the crenellations of the turns on the insertion tool, combined with the fact that the insertion of the turns into the slots is carried out by an axial movement of the tool, makes it possible to practically not deform the wires during insertion. Thus, the crossing areas 61, which

undergo a particular shaping before insertion, are not deformed and come to be ~~organised~~
organized correctly in the winding overhangs of the rotor.

Please replace paragraph [0156] with the following amended paragraph:

[0156] In all cases, when the rotor support shaft turns, the fan or fans make it possible to create an air current between the air inlet and outlet openings passing through the winding overhangs of the winding according to the invention. More precisely, the step of preparing the wires separately, and then the step of ~~organising~~organizing the phase windings before their insertion into the slots, make it possible to give the end windings, referred to as winding overhangs, of the stator symmetrical characteristics making it possible to create in the winding overhangs air flow apertures and slopes which improve the circulation of the air through the winding overhangs, for example above 10 ~~litres~~liters per second.

Please replace paragraph [0158] with the following amended paragraph:

[0158] Of course, the slot insulators are placed and advantageously fixed in the slots before the wires are inserted into the slots. For simplicity, ~~Figures~~Figs. 11A and 11B do not depict the slot insulator that can be seen in ~~Figures~~Figs. 1A, 2B, 9 and 11C.

Please add the following new paragraphs after paragraph [0162]

[0162.1] While the method herein described, and the form of apparatus for carrying this method into effect, constitute preferred embodiments of this invention, it is to be understood that the invention is not limited to this precise method and form of apparatus, and that changes may be made in either without departing from the scope of the invention, which is defined in the appended claims.

[0161.2] What is claimed is: